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TRAFFIC ANALYSIS AND DESIGN OF FLYOVER

Rose Mary Xavier[1], Evelyn Antony[2], Jubin Mathew[3], Paul P Shibu[4], Safna K Muhammed[5]

[1]Assistant Professor, Department of Civil Engineering Viswajyothi college of Engineering and Technology, Vazhakulam, Kerala, India

[2,3,4,5]UG Scholar Department of Civil Engineering, Viswajyothi college of Engineering and Technology, Vazhakulam, Kerala, India

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Abstract - *Transportation is one of the most important aspect of a developing nation and is necessary for ensuring the growth of urban areas. In India, due to rapid increase in population along with urbanization and improved living condition, the vehicular population have increased massively. Traffic congestions has become a major problem at intersections. The main objective of this project is to analyze traffic problems at a suitable intersection and suggesting an alternate solution. In this study, we have taken three main intersections, two at muvattupuzha (P.O junction and Velloorkunnam junction) and one at thodupuzha (Vengalloor junction). After analyzing and comparing peak values of 3 intersections, junction with highest peak value is selected. According to IRC: SP: 90-2010, manual for grade separators and elevated structures the maximum volume a rotary can handle is specified as 5000pcu/hr and an elevated structure could be provided beyond this limit. A simple grade separator, that is, a flyover is provided at this intersection to segregate the high volume of traffic. With the flyover bridge at the intersection, a major proportion of the traffic volume could be diverted to the bridges, and time delay can also be reduced over the same period. Thus, the traffic pass at two different levels and leaves no chance for an accident. If this project is implemented, the present and future demands of the traffic flow will be satisfied.*

Key Words: Urbanization, Traffic congestion, alternative solution.

1. INTRODUCTION

1.1 General

Rising traffic congestion is an inevitable condition in large and growing metropolitan cities across the world. Increase in human population has resulted in an extensive increase in vehicular population. Nowadays people are shifting from slower less expensive modes of transport to privately owned cars leading to more traffic problems. People suffer from the daily inconvenience caused due to delayed traffic. The causes of traffic congestions include improper planning of roads in terms of considering future capacity. So, traffic analysis is essential for improvement of existing facilities and future needs of the road.

In this paper, traffic congestions are evaluated at selected intersections and data regarding the traffic volume are collected manually through direct field surveys. After analysing the collected data various remedial measures are proposed focusing on junction improvement and alternative operation plan. Despite of the huge investment to be laid, congestions could be reduced to a certain extent by providing signalized traffic junctions, providing roundabouts, flyovers, interchanges, etc.

1.2 Objectives

a) To evaluate traffic congestion at selected intersections.

b) To carry out classified Volume Count through survey.

c) To determine the service flow rate in PCU units.

d) To suggest an alternative possible solution to reduce traffic delay.

1.3 Scope

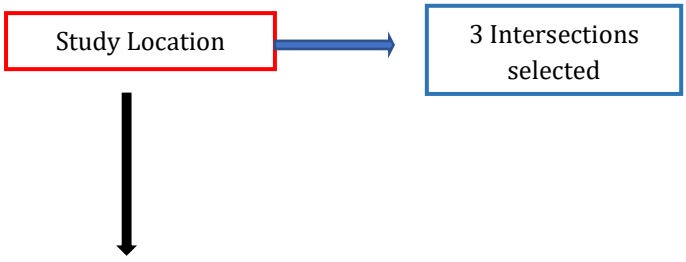
a) To achieve efficient and rapid flow of traffic at intersection.

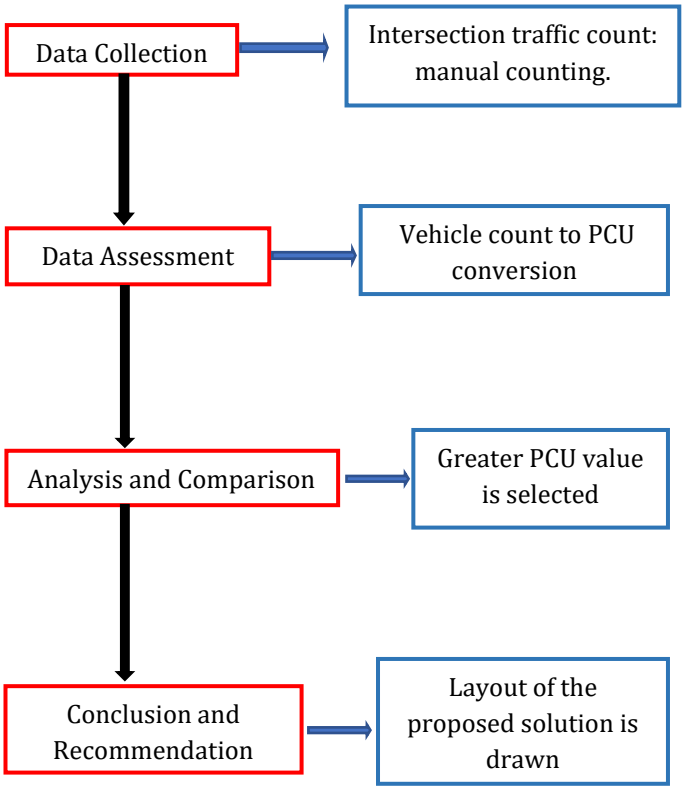
b) To increase the traffic capacity of roads.

c) To reduce the delays in road journeys and improve speeds of vehicles.

2. RESEARCH FRAMEWORK

The methodology consists of 5 steps, from selecting the intersection to providing layout of the alternative solution. After choosing the right intersection based on the analysis on the tabulated data, field measurements are taken for the same intersection. Then an alternative solution is suggested for reducing the traffic congestion.





3. STUDY LOCATION

The first step of the research work is the selection of the study area. Study area is selected according to the existing road traffic behaviour and transport framework. Data is collected from study area and with the help of data analysis, some implementation will produce to upgrade the condition of the road. It will give a positive impact to the people around and other road users. The study was conducted at three junctions velloorkunnam, vengalloor and P.O signal (Muvattupuzha). The area first analysed is velloorkunnam signal junction which is intersected with NH 85, SH 1, SH 41. The 3 main roads meeting at the intersection are Perumbavoor, Muvattupuzha and Kolenchery roads. The survey was taken on 11/01/2021. The next area analysed is vengalloor signal junction which is intersected with SH 44, SH 41, SH 8. The 4 main roads meeting at the intersection are Thodupuzha, Muvattupuzha, Pala, and adimali roads. The survey was taken on 4/01/2021. The third study area was P O signal junction muvattupuzha which is intersected with SH 1, SH 41, SH 8. The 3 main roads meeting at the intersection are Velloorkunnam, 130 junction road, and thodupuzha. The observation was taken on 18/01/2021.

Table -1: Salient features of Intersection

INTERSECTION	SALIENT FEATURES	LOCATION MAP
P O JUNCTION MUVATTUPUZHA	i. Intersecting SH 1, SH 8, SH 41. ii. Pedestrian crossing at each arm. iii. KSRTC bus stand nearby. iv. Moderate traffic.	
VELLOORKUNNAM SIGNAL JN	i. Intersection of 3 roads — which includes NH 85, SH 1, SH 41. ii. Pedestrian crossing at each arm. iii. Heavy traffic.	
VENGALLOOR SIGNAL JN	i. Intersection of 4 road – which includes SH 44, SH 41, SH 8. ii. Pedestrian crossing at each arm. iii. Moderate traffic	

4. DATA COLLECTION AND ANALYSIS

4.1 Data collection method

There are mainly 2 categories in traffic counting, they are manual counts and automatic counts. In this study the method used is manual counting and it is done by using tally marks. Raw data from those inventories is then organized for analysis. The traffic on each arm is counted and recorded separately for each movement. The other method is automatic counting method which involves various types of instruments which have their own merits and demerits. Some of the widely used instruments are pneumatic tubes, inductive loops, weigh-in-motion sensor, micro-millimetre and video camera. Here the method adopted is manual counting of different category of vehicles, since it is a direct and easy method involving no expensive equipment

4.2 Estimation of PCU

Passenger Car Unit (PCU) is a weightage factor given to the traffic volume particular vehicle type will be affected by a certain extent to increase in its proportion in total traffic. Considering all these factors, the PCU conversion factor for each category of vehicles are recommended by IRC 106-1990 table 1. Accordingly, each category of vehicle is multiplied with their respective conversion factor to express the capacity of urban roads in terms of a common unit of specific vehicle category to deal with the mixed traffic situation. PCU is an approach used to convert the heterogeneous traffic volume to its equivalent homogeneous. Use of appropriate PCU value for separate vehicle categories will lead to correct measure of homogeneous traffic volume in the mixed traffic situation which holds significance in providing the desired level of service. IRC 106-1990 provides the PCU factors for different categories of vehicles. The equivalent PCUs of different vehicular categories do not remain constant under all circumstances. In urban situations, the speed differential amongst different vehicle classes is generally low, and as such the PCU factors are predominantly a function of the physical dimensions of various vehicles. One car is considered as a single unit, cycle or two wheelers are considered as half or three-fourth of a car unit depending upon the percentage. Bus, truck causes a lot of inconvenience because of its large size and is considered to be 2.2 or 3.7 according to their total percentage. Also, the PCU of a particular vehicle type will be affected by a certain extent to increase in its proportion in total traffic. Considering all these factors, the PCU conversion factor for each category of vehicles are recommended by IRC 106-1990 table 1. Accordingly, each category of vehicle is multiplied with their respective conversion factor to express the capacity of urban roads in terms of a common unit.

4.2 Traffic Volume Count

Table -2 : Traffic survey results at Velloorkunnam signal

Name of Intersection :Velloorkunnam Signal				
Name of Arm	Total Vehicles	Total Vehicles in pcu	Hourly Volume	Hourly Volume in pcu
9.00 – 10.00 AM				
Muvattupuzha - Kolenchery route	595	997.85		
Perumbavoor - Muvattupuzha route	1878	2372.95		
Muvattupuzha - Perumbavoor route	1528	2158.3	4001	5529.1
3.00 – 4.00 PM				
Muvattupuzha - Kolenchery route	612	1213.5		
Perumbavoor - Muvattupuzha route	1310	1800.2		
Muvattupuzha - Perumbavoor route	1359	1964	3281	4977.7
4.00 – 5.00 PM				
Muvattupuzha - Kolenchery route	1095	1551.65		
Perumbavoor - Muvattupuzha route	1721	2285.3		
Muvattupuzha - Perumbavoor route	1625	2277.6	4441	6114.55

Table -3: Traffic survey results at P.O signal

Name of Intersection :P.O Signal				
Name of Arm	Total Vehicles	Total Vehicles in pcu	Hourly Volume	Hourly Volume in pcu
9.00 – 10.00 AM				
Muvattupuzha - Thodupuzha route	440	686.05		
Muvattupuzha - Velloorkunnam route	974	1280.1		
Muvattupuzha - 130 JN	537	887.65	1951	2853.8
3.00 – 4.00 PM				
Muvattupuzha - Thodupuzha route	389	708.85		
Muvattupuzha - Velloorkunnam route	874	1250.15		
Muvattupuzha - 130 JN	440	938.1	1703	2897.1
4.00 – 5.00 PM				
Muvattupuzha - Thodupuzha route	662	1010.6		
Muvattupuzha - Velloorkunnam route	832	1203.55		
Muvattupuzha - 130 JN	573	847.55	2067	3061..7

Name of Intersection :Vengalloor Signal				
Name of Arm	Total Vehicles	Total Vehicles in pcu	Hourly Volume	Hourly Volume in pcu
9.00 – 10.00 AM				
Muvattupuzha - Thodupuzha route	1195	1560.4		
Thodupuzha - Muvattupuzha route	985	1738.2		
Vengalloor - Pala route	737	1000.5		
Vengalloor - Adimali route	440	521.55	3734	4820.65
3.00 – 4.00 PM				
Muvattupuzha - Thodupuzha route	1372	1614.7		
Thodupuzha - Muvattupuzha route	1179	1488.25		
Vengalloor - Pala route	802	1165.7		
Vengalloor - Adimali route	489	592.45	3842	4861.1
4.00 – 5.00 PM				
Muvattupuzha - Thodupuzha route	1294	1564.9		
Thodupuzha - Muvattupuzha route	1061	1442.2		
Vengalloor - Pala route	701	831.8		
Vengalloor - Adimali route	489	517.85	3545	4356.75

Table -4: Traffic survey results at Vengalloor Signal

4.2 Estimation of Level Of Service (LOS)

Level of service is the qualitative measure describing operational conditions of roadway, and their perception by drivers and passengers. Six levels of service are designated by IRC 106-1990 from A to F.

Level of Service A: Represents a condition of free flow with average travel speeds. The level of comfort and convenience provided to the road users is excellent. The value ranges between 0.3 to 0.39.

Level of Service B: Represents a zone of stable flow where drivers have the freedom to select their desired speed. Level of comfort and convenience provided is less than the Level of Service A. It ranges between 0.4 to 0.49

Level of Service C: The general level of comfort and convenience declines at this level. It ranges between 0.5 to0.59.

Level of Service D: Represents a limit of stable flow, where conditions are approaching close to an unstable flow. Slight increase in traffic flow can cause operational problems at this level. It ranges between 0.6 to 0.69

Level of Service E: Represents operating conditions when traffic volumes are at or close to their capacity level.

Level of Service F: Represents a zone of forced or breakdown flow.

Table 5: Operational conditions of traffic stream

STUDY AREA	NAME OF ARM	(V) PCU/ HOUR	DSV	V/ DSV ratio	LOS
Velloorkunnam junction	Perumbavoor-Muvattupuzha	2285.3	3600	0.63	D
	Muvattupuzha-Perumbavoor	2277.6	3600	0.63	D
	Muvattupuzha-Kolenchery	1551.65	3600	0.43	B
P O signal junction	Muvattupuzha-Velloorkunnam	1280.1	3600	0.35	A
	Muvattupuzha-Thodupuzha	1010.6	3600	0.3	A
	Muvattupuzha-130 jn	938.1	3600	0.3	A
Vengalloor junction	Muvattupuzha-Thodupuzha	1359	3600	0.38	A
	Thodupuzha-Muvattupuzha	1302.2	3600	0.36	A
	Vengalloor-Adimali	467.65	3600	0.13	-
	Vengalloor-Pala	712	3600	0.12	-

4.3 Finalization of an intersection

The traffic flow along a road doesn't remain constant throughout the day or week but varies with both space and time. The peak hour represents the most critical period for operations and has the highest capacity requirements for a given location. On comparing the Traffic volume count datas and also the tabulated Level of Service of the 3 intersections (Vengalloor signal, Velloorkunnam signal and P.O signal), it is clear that most congested junction is the Velloorkunnam signal. The maximum traffic volume is obtained for the Velloorkunnam signal which is about 6114.55 pcu/hr. The peak hour of this signal junction was found to be 4.00 to 5.00 pm. During peak hours, the vehicles experience slower speeds, longer trip times and increased vehicular queuing at the signal. Due to the high density, drivers are severely restricted in their freedom to select desired speed and manoeuvre within the traffic stream. The general level of comfort and convenience is poor at this intersection.

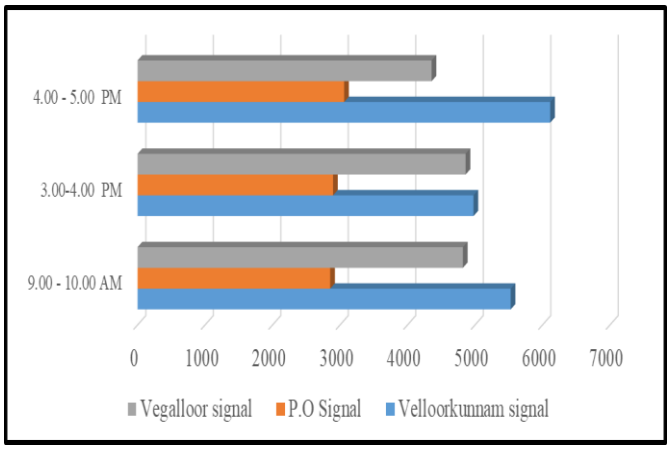


Chart- 1: Variation of Traffic Volume at 3 intersections

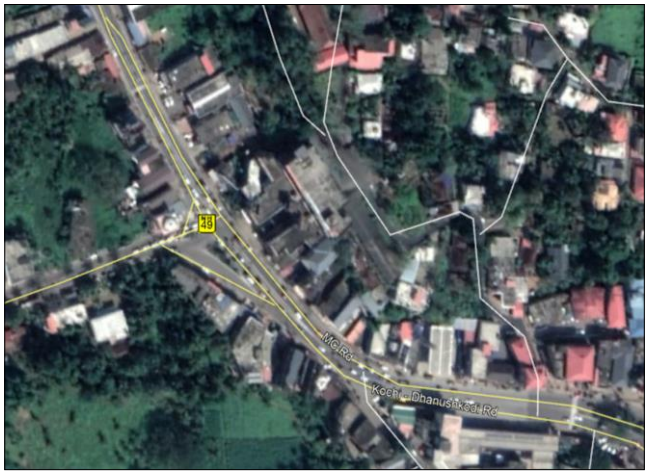


Fig -1: Existing condition of Velloorkunnam Signal

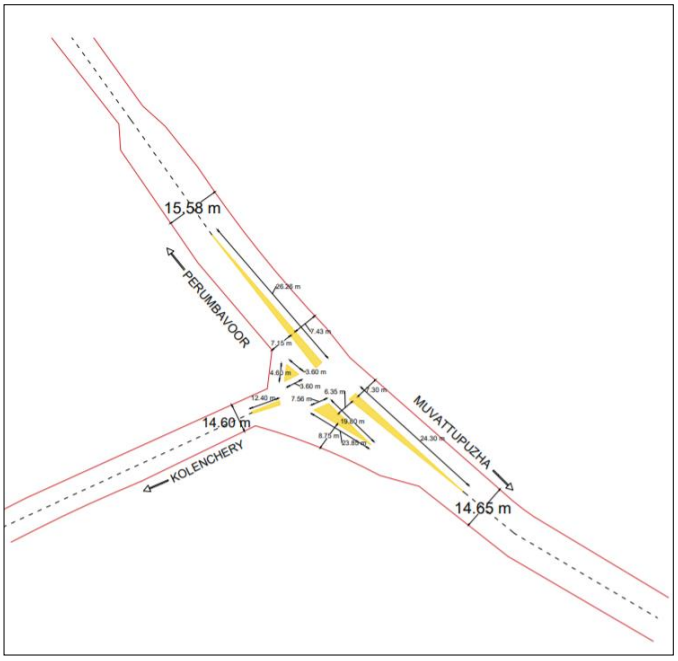


Fig -2: Field measurements of Velloorkunnam Signal

5. PROPOSED SOLUTION

After analyzing and comparing peak values of 3 intersections the velloorkunnam signal junction with a highest peak value of 6114.55 pcu/hr is selected. From the capacity calculations made from field data it is evident that this intersection would fail to cater to the future traffic demands. IRC:65-2017, Guidelines for planning and design of roundabouts, specifies the traffic volume a roundabout can handle efficiently is 3000 pcu/hr. According to IRC: SP: 90-2010, Manual for grade separators and elevated structures the maximum volume a rotary can handle is specified as 5000 pcu/hr and an elevated structure could be provided beyond this limit. And also, an interchange is recommended only when the traffic volume is above 10,000 pcu/hr. A simple grade separator, that is, a flyover at this intersection would be the most feasible way to segregate the high volume of traffic.

As the traffic on the road goes on increasing and have limited space left in the both dimensions, then the only option left will be, is to go with the third dimension and that is done through flyover construction. Flyovers are overpass or a high-level road bridge that crosses over a highway interchange or intersection. It is a grade separator built over a traffic intersection to allow people to literally 'fly over' the traffic. With the flyover bridge at the intersection, a major proportion of the traffic volume could be diverted to the bridges, and time delay can also be reduced over the same period. In case of a Simple flyover, the main road used for fast traffic is made to pass by a high level by a bridge, providing ramps on both the approaches and slow traffic is made to pass underneath. Thus, the traffic pass at two different levels and leaves no chance for an accident. It requires a large area of land. All the conflicting stream of traffic are avoided, and so traffic can move at its own speed.

Roundabouts were found to be a suitable solution to manage the traffic flow under the flyover. Roundabouts are a type of circular intersection or junction in which road traffic flows continuously around the central island. The vehicles entering the roundabout are gently forced to move in a clockwise direction. These are efficient intersection design over signalized intersections depending upon the traffic and site data.

5.1 2D Layout

2D layout of the flyover is plotted in AutoCAD considering the existing measurements. The median of existing and the proposed layout are kept the same and lanes are offsetted from the median to both the sides.

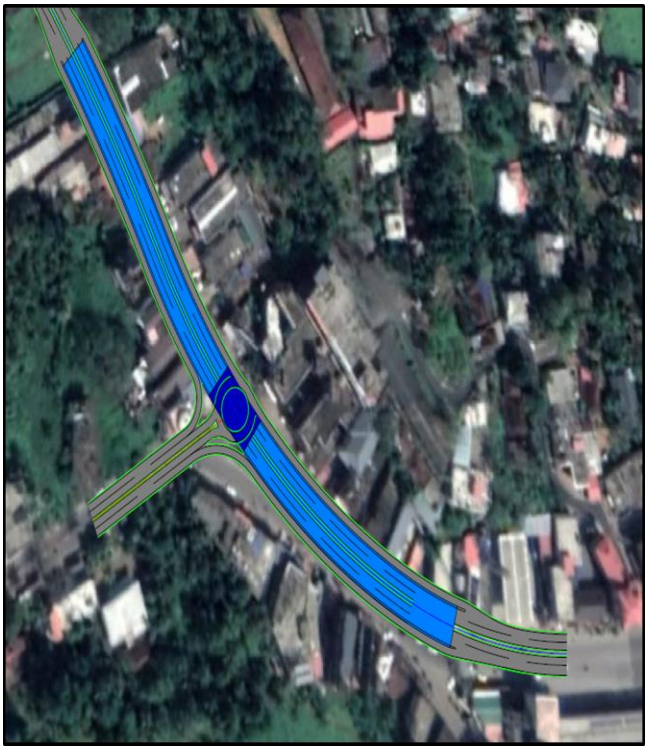


Fig -3:2D Layout of flyover in the location
(Light blue represents ramps and dark blue bridge)

5.2 Detailed View

Standard measurements of lane width (3.5m), shoulder width (0.6m to 1m), median (2m) are provided in IRC: SP: 73-2015, Manual for specifications and standards for two laning of highways. According to IRC:3-1983, Dimensions and Weights of road design vehicles, no vehicle other than double decker buses shall have a height exceeding 3.8m for normal application and double decker buses may have a height not exceeding 4.75 m. Therefore, according to Indian Standards, the height of flyover should be 5.5m. A Bridge

with a deck slab of height of 3.5 m is provided making the total height of the flyover to be 9m. Slope of the ramp is generally expressed in percentages. According to IRC: 92-1985, Guidelines for the design of Interchanges, the slope should be limited to a maximum of 4 per cent and should not exceed 6 per cent. So, providing a slope of 5% would be suitable which means a gradient of 1:20(1m vertical rise in every 20 m horizontal).

According to IRC 65-2017, Guidelines for Planning and Design of Roundabouts, a single lane roundabout should typically have an inscribed circle diameter of 28m to 40 m. The central island diameter depends upon the inscribed circle diameter and required circulatory roadway width. The inscribed circle of roundabout provided is 30 m in diameter with a circulatory carriageway width of 5.2m. The radius at the entry depends on various factors like design speed, super elevation and coefficient of friction. The entry of roundabout is not straight, but a small curvature is introduced. This will force the driver to reduce the speed. The entry and exit radius in a single lane roundabout typically range between 15m to 30m. There is a general practice to keep the exit radius as 1.5 to 2 times the entry radius. However, if pedestrian movement is higher at exit approach, then exit radius could be set as same as that of entry radius. The entrance width is dictated by the needs of the entering traffic stream, typically ranges from 4 m to 5.5 m width.

Height of flyover = 5.5 m (bottom), 9 m (top)
Slope of Ramp = 5%
Length of each ramp = 9*(100/5) =180 m
Central island diameter = 30 – (2*5.2) = 19.6 m
Entry and exit radius = 15 m
Entry and exit width = 4.2 m

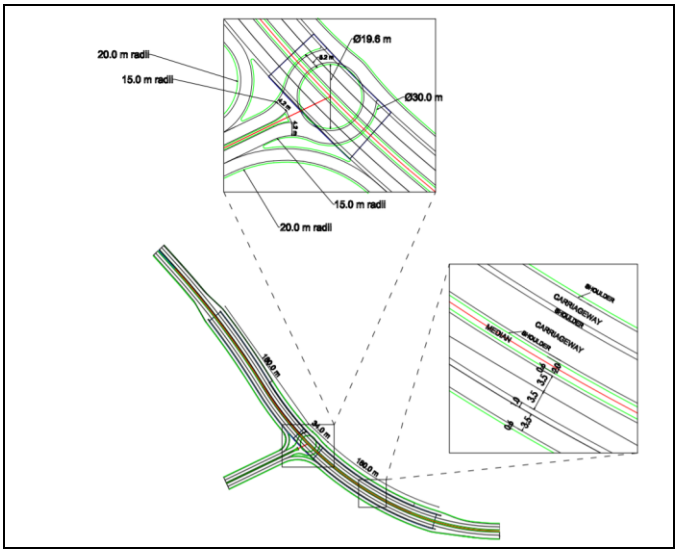


Fig -4: Measurements of 2D Layout

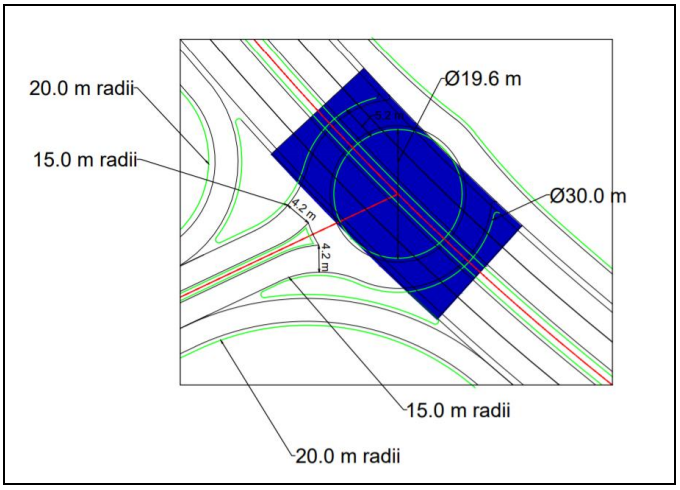


Fig -5: Dimensions of roundabout

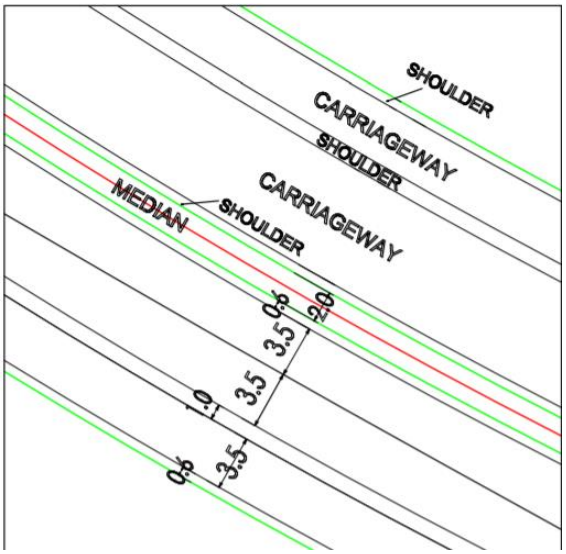


Fig -6: Dimensions of roadwidth

5.3 3D Views in SketchUp

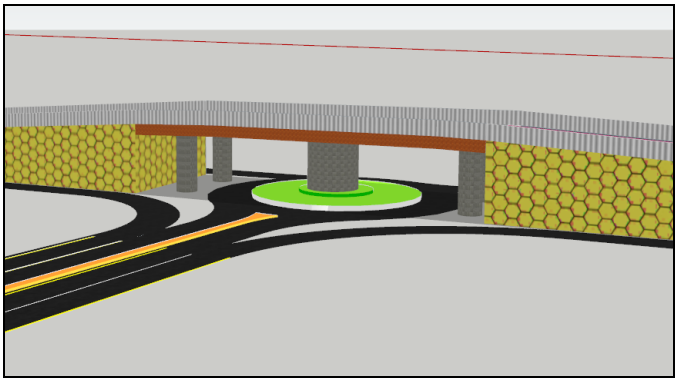


Fig -7: 3D View of Bridge

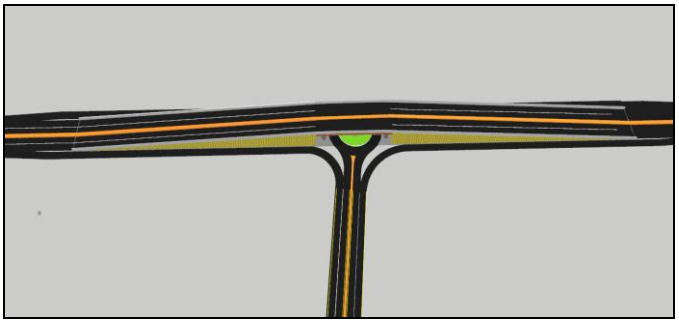


Fig -8: Top view of the flyover

5.4 3D Views in 3DSMax

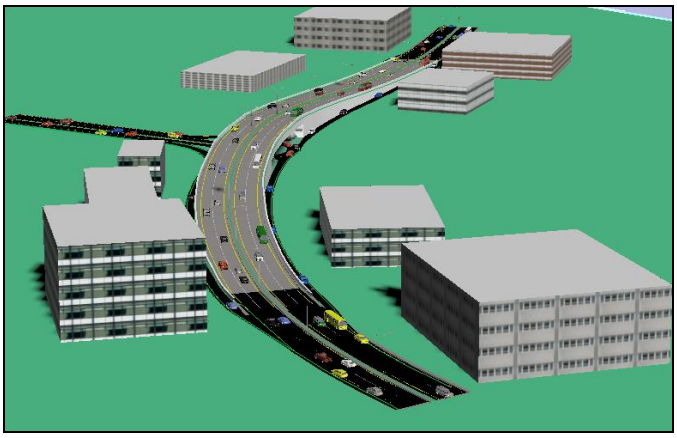


Fig -9: Perspective view of flyover

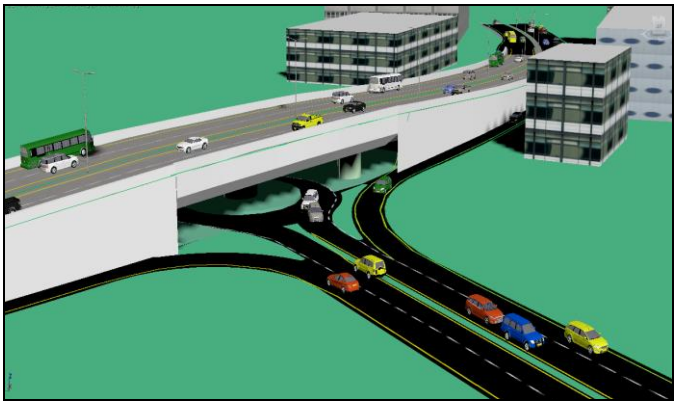


Fig -10: 3D View of bridge

Fig -11: Street view of flyover

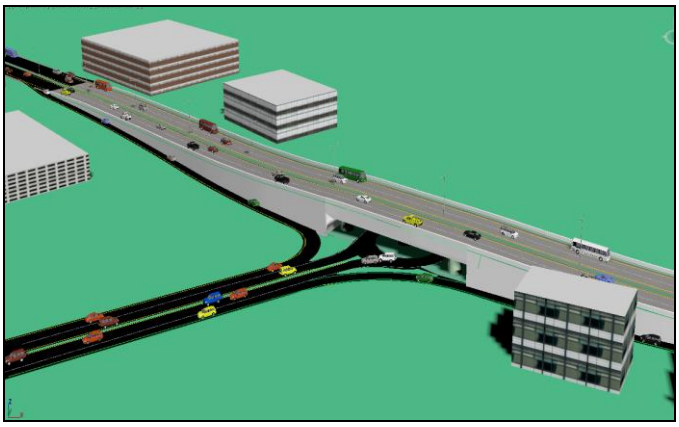


Fig -12: Aerial view of the flyover

6. ADVANTAGES AND DISADVANTAGES

The advantage of the project is that by the construction of a flyover, it avails to minimize traffic congestion and thus reduces travel time. Flyovers play a major role in streamlining the traffic control system. It helps to abbreviate waiting time at the intersection. The effect of pollution can be reduced and it also decreases the risk of accidents. Flyover helps to increase the capacity of road (vehicles per km) without changing road geometrics and thus the speed of the vehicle can be increased. It also contributes a lot to the aesthetic view of the city. Flyover avails to truncate traffic conflict points at the junction. It also provides facile, expeditious and safe access of public transportation service.

Flyovers contain several advantages, but there are limitations which arise due to several mistakes committed at some stage in their construction. Flyovers are not as a rule suitable for built-up areas as they require a large area and it is costly. Land acquisition is also required for its construction. Lack of proper management in the flyover construction also causes many problems. This project deals with traffic analysis and proposing a design layout for a flyover, hence it is not detailing about the structural aspect.

7. CONCLUSION

Increase in population and rapid urbanization in India have resulted in increased usage of vehicles and transportation facilities, which in turn results in traffic congestion and related problems. The project study is based on 3 main intersections and traffic data is collected manually on peak hours which is then converted to common PCU unit. After comparing peak values of 3 intersections, velloorkunnam signal junction with a highest peak value of 6114.55 pcu/hr is selected. Field measurements are done using total station. The maximum volume a rotary can handle is 5000 pcu/hr and elevated highways can carry beyond this limit. So, an alternate solution suggested is the implementation of a flyover. The height of the flyover is given as 5.5m based on Indian Standards. Also, a bridge with a deck slab of height 3.5m is provided making total height of the flyover to be 9m. The length of each ramp is given as 180m with a slope of 5 percent. All measurements are provided as specified on IRC codes. Although governments may never be able to eliminate road congestion, with the flyover construction it could be reduced to a certain extent and crisis can be mitigated well. Despite of the huge investment to be laid, it would provide an easy, safe and fast transportation. If the project is implemented the present and future demands of the traffic may be satisfied.

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BIOGRAPHIES

Rose Mary Xavier
Assistant Professor
Dept of Civil Engineering
Viswajyothi college of Engineering and technology, Kerala

Evelyn Antony
4th year Student, Civil Engineering
Viswajyothi college of Engineering and technology, Kerala

Jubin Mathew
4th year Student, Civil Engineering
Viswajyothi college of Engineering and technology, Kerala

Paul P Shibu
4th year Student, Civil Engineering
Viswajyothi college of Engineering and technology, Kerala

Safna K Muhammed
4th year Student, Civil Engineering
Viswajyothi college of Engineering and technology, Kerala